

# **LEAD IN DRINKING WATER**

**FINAL REPORT**  
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**Virginia Department of Health**

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## Abbreviations and Acronyms

CLPPP	Childhood Lead Poisoning Prevention Program
DCLS	Division of Consolidated Laboratory Services
EPA	U. S. Environmental Protection Agency
LCCA	Lead Contamination Control Act of 1988
LCR	Lead and Copper Rule of 1991
LHD	Local Health Department
NTNC	Non-transient noncommunity waterworks
ODW	Office of Drinking Water
ppb	Parts per billion (one ppb equals one $\mu\text{g/l}$ )
SDWIS	Safe Drinking Water Information System
SDWA	Safe Drinking Water Act
VDH	Virginia Department of Health
WASA	Washington D.C. Water and Sewer Authority
$\mu\text{g/l}$	Micrograms per liter (one $\mu\text{g/l}$ equals one ppb)

## **Introduction to the Perceived Lead Crisis of 2004**

In the spring of 2004 significant public and media interest was focused on the Washington, D.C. area, following disclosures of elevated lead levels in drinking water by the Washington D. C. Water and Sewer Authority (WASA). Unexpectedly high tap sampling results had prompted WASA to extend its sampling program, focusing on such possible causes of the high lead levels as changes in treatment chemistry, or replacement of service lines and meters. Public confidence in the water supply was severely compromised because of the considerable time it took WASA to notify participating homeowners of sample results showing elevated lead levels. These events raised the question of whether there were elevated levels of lead in water supplied to groups that were especially sensitive, such as infants and children.

In response to the events in Washington, D.C., the Virginia Department of Health (VDH) determined that it was critical to address the public and media perceptions that existing policies and protocols, intrinsic to the federal Lead and Copper Rule (LCR), were not adequate to ensure public health protection in Virginia. This led VDH to

1. vigorously implement a sampling strategy to evaluate the possible extent of lead in drinking water provided to high-risk populations in elementary schools and child daycare facilities throughout Virginia,
2. disseminate educational materials to all elementary schools and child daycare facilities throughout the state, and
3. perform a comprehensive analysis of existing lead sampling data accumulated by public waterworks throughout Virginia to assess the compliance status of facilities already subject to regulations aimed at minimizing the incidence of lead in drinking water.

VDH quickly mobilized staff and agency resources to perform these tasks. The purpose of this report is to document the development, implementation, and outcomes of the Lead Action Plan that VDH devised in the spring of 2004.

## **Regulatory and Historical Background**

The federal Lead Contamination Control Act (LCCA) of 1988 instituted the following:

- recalled drinking water coolers with lead-lined water reservoir tanks,
- banned new drinking water coolers with lead parts,
- banned the use of lead solder, and
- restricted the amount of lead in fixture units.

The LCCA also established a technical assistance program to support state activities to reduce lead contamination in elementary schools. In addition, the LCCA tasked states with the distribution of printed education materials directed to consumers, with information for consumers on means to reduce their exposure to lead in drinking water.

EPA regulates lead in drinking water through the Lead and Copper Rule (LCR) of 1991. The LCR instituted a program of extensive initial sampling for Lead and Copper. Unlike most drinking water contaminants, compliance with standards for lead in drinking water is principally based on sampling performed at consumer taps, since almost all lead contamination to which consumers might be exposed occurs due to the corrosion of lead-bearing plumbing materials in the home. Under the rule, waterworks select a pool of prospective sampling sites from locations at greatest risk of lead corrosion. Taps at single family residences are preferentially selected for community waterworks, to the exclusion of consumer taps located in civic or commercial buildings. However, nontransient noncommunity (NTNC)

waterworks, such as schools and factories with their own water supplies, are also subject to LCR sampling requirements.

Public waterworks are required to inventory their distribution system materials as a preliminary step when establishing their pools of acceptable sampling sites under the LCR. The rule stipulates that samples will be preferentially collected at sites with plumbing most likely to contribute lead (and copper) when exposed to corrosive or aggressive water. Prospective sampling pools are then ranked in Tiers and Categories according to the relative proportions of lead-bearing materials in use. Waterworks that deliver water through lead service lines are ranked in the highest risk Tier/Categories, which are defined as follows:

- 1A** Single family residences with 50% lead service lines and 50% copper pipe installed between 1983 and 1986.
- 1B** Single family residences with some (<50%) lead service lines and the remainder with copper pipe installed between 1983 and 1986.

The rule mandates the minimal number of sites to be sampled based on the waterworks' service population. Community waterworks usually have to enlist the assistance of cooperating tenants or homeowners for sample collection.

The LCR specifies that compliance samples are collected as first draw samples from cold water taps. Sample taps must remain idle for between six to ten hours, with analysis performed on the first liter of water to flow through the tap after this mandatory idle time. If lead-bearing components are present in the plumbing system, and if the water is demonstrably corrosive, this "first draw" sample is most likely to reveal the presence of lead, depending on the length of time the water remains in contact with the lead-bearing components.

The exposure standard for lead is expressed as an action level, which is set at 15 µg/L (ppb). Because multiple samples are collected for each sampling event, compliance is based on the 90<sup>th</sup> percentile lead concentrations from each sample set.

When results from tap sampling indicate that more than 10 percent of the tested homes have lead concentrations that exceed the action level, public waterworks must take actions to control corrosion. In addition, waterworks that employ lead service lines must perform systematic line replacement (with non-lead bearing materials) if, after installing and optimizing corrosion control treatment, the lead action level is still exceeded during further first draw tap sampling events.

According to the LCR, waterworks with 90<sup>th</sup> percentile results that exceed the lead action level must also disseminate public education materials designed to inform consumers about steps they should take to protect their health. The LCR specifies that the public notices are to be distributed to the entire service population. However, there is no explicit LCR requirement that site-specific results be provided to cooperating homeowners, nor does the LCR suggest a timetable or method for notifying homeowners of any site-specific results.

The LCR establishes waterworks' on-going sampling frequencies based on their sampling histories. Public community and NTNC waterworks began extensive sampling for lead at consumer taps in the early 1990s, at the time the LCR was adopted. Most public waterworks in Virginia currently conduct on-going, first draw tap sampling on a three year cycle, based on previous testing results.

VDH fully implemented all provisions of both the LCCA (in cooperation with the Department of Education) and the LCR.

## **The VDH Lead Action Plan**

In response to the concerns raised following the WASA incident, VDH formed a Working Group, comprised of members from various agencies, offices, and divisions, to direct the Department's strategy for a lead investigation (Appendix A). The Working Group devised and implemented a three-part action plan (Appendix B).

First, a pool of child daycare facilities and elementary schools was identified for a special sampling program, which included analysis of first-draw and 60 second flush water samples from commonly used taps.

Secondly, child daycare facilities and elementary schools (both publicly and privately owned) were provided with educational materials describing proven ways to reduce children's exposure to lead in drinking water.

Finally, VDH performed a comprehensive review of lead data from community waterworks throughout Virginia. Public waterworks were encouraged to perform voluntary testing, and to notify individual consumers promptly if site-specific test results exceed the action level.

### **Sampling Program for Child Daycare Facilities and Elementary Schools**

Since lead exposure is problematic for children in the earliest developmental stages, the Working Group called for state-wide sampling of drinking water at selected child daycare facilities and elementary schools throughout Virginia. Elementary schools and child daycare facilities that obtain their drinking water as customers of municipal water supplies are usually excluded from routine sampling under the LCR, which emphasizes sampling at residential taps. Some elementary schools and child daycares, especially those in rural areas, operate as NTNC public waterworks in their own right, and are subject to



LCR sampling requirements. However, many of these facilities sample infrequently, as allowed by the rule. The Working Group developed and executed the following protocols to determine the prevalence of lead in drinking water at the previously untested facilities, and to obtain fresh data from the regulated elementary school and child daycare waterworks:

1. A pool of priority facilities considered eligible for sampling was generated according to the following criteria:
  - Elementary schools and child daycares identified in the Safe Drinking Water Information System (SDWIS) as NTNC waterworks were excluded from the priority pool if sampling data were available for the 2003 to 2004 monitoring period.
  - Similarly, child daycare facilities and elementary schools in SDWIS that were scheduled for compliance sampling in 2004 were excluded from the priority pool.
  - Elementary schools in Northern Virginia that sampled recently were excluded. However, staff from the ODW Culpeper Field Office provided technical assistance to utilities and school systems in the Northern Virginia region. The Culpeper Field Office also tracked and evaluated the sampling results from Northern Virginia facilities as they became available (Appendix C).
  - Out-of-home child daycares, unlicensed child daycares, and child daycares with religious exemptions were excluded.
2. The Working Group tasked ODW with the selection of 250 potential sampling sites from the priority pool. The selected sites were chosen to afford statewide coverage, with approximately two sample sites per county or independent city. Additional sites were selected in the Tidewater and Richmond areas at the request of the Childhood Lead Poisoning Prevention Program

(CLPPP), to correspond to CLPPP's planned environmental sampling in those regions (Appendix D).

3. Sample collection was carried out by staff from Local Health Departments (LHDs), under guidance provided by ODW. Staff collected a first draw sample at a tap deemed to be the most critical location (most frequently used potable water fixture) at the most critical time (first use in the morning). A second, 60-second flush sample was taken after a timed flush of the chosen tap. Samples were delivered via a contract courier to the Division of Consolidated Laboratory Services (DCLS) for analysis. A copy of the sampling protocol and the results notification letter is provided in Appendix E.
4. If the first draw or 60-second flush samples showed lead levels higher than the action level of 15 µg/L, LHD staff revisited the site and resampled the tap following the same sampling protocol.
5. For 60-second flush sample results that continued to show lead levels greater than 15 µg/L, ODW was prepared to send field staff to perform on-site investigations to determine why the level of lead was above the action level, and to offer recommendations on corrective measures the facility could employ.
6. LHD staff notified the participating elementary schools and child daycare facilities of their sampling results. ODW Field Offices were provided copies of the results for forwarding to the waterworks for informational purposes. Samples of the notification letters are provided in Appendix E.

7. CLPPP was tasked with developing and implementing environmental studies (principally of dust and soil) at priority sites in Richmond and Norfolk, where appropriate. These data are to be tabulated and reported separately from this report.
8. LHD clinics were on alert to perform blood testing for lead in accordance with their normal protocols, in response to increased citizen demand (if any).

### **Distribution of Educational Materials to Child Daycare Facilities and Elementary Schools**

VDH developed a cover letter and Fact Sheet that explained the health effects of lead and precautions that could be taken by consumers to reduce concentrations of lead in drinking water, if present. The Fact Sheet also provided information on lead testing, and ODW and EPA website addresses for those seeking additional information. The ODW webpage included additional information and direct links to pertinent EPA websites. The Virginia Department of Education and the Council for Private Schools were enlisted to provide educational materials directly to all elementary schools in the state electronically. VDH provided similar educational materials to all child daycare facilities via a mass mailing.

Critical subtasks of this educational effort were conducted by ODW staff, including

- Developing a cover letter and Fact Sheet for elementary schools and child daycares (Appendix F).
- Submitting the letter and Fact Sheet to the Department of Education and Council for Private Schools for electronic distribution to 1800 public schools and 460 private schools for grades K through 12.
- Obtaining an accurate child daycare facilities mailing list.
- Mass mailing materials to approximately 10,000 child daycare facilities throughout Virginia.
- Creating a Lead web page, adding related links, and adding educational materials (Appendix F).

CLPPP has inserted a guide with information on ways to protect children from lead exposure in a Daycare Provider Tool Kit. This tool kit is currently being distributed to all daycare providers through area training sessions.

## **Status of Community Waterworks**

The Working Group tasked ODW with the review of the compliance status of active community waterworks, which are required to monitor lead in drinking water under the LCR.

A letter discussing the lead in drinking water issues was sent from the Commissioner to the 1,167 owners or operators of Virginia's community and NTNC waterworks (Appendix G). The letter recommended that additional voluntary lead sampling be conducted in response to public interest and concern. The letter also noted that waterworks were expected to notify the owners of participating premises in a timely manner of any sample results that exceeded the 15 µg/L lead action level.

ODW also altered the contents of the standard comment letters sent to community waterworks owners upon review of the waterworks' routine LCR sampling results (Appendix G). Language was added to highlights the agency's expectation that waterworks owners will notify individual participants of their site-specific results if the lead concentration is found to be greater than the 15 µg/L action level at that location. The enhanced transmittal letters also direct waterworks owners to offer appropriate technical assistance to sampling participants, including educational information on methods for reducing exposure to lead in drinking water.

ODW reviewed the lead sampling data from all waterworks with Tier/Category 1A and 1B designations, to verify the compliance status of waterworks that might be subject to mandatory lead service line replacement requirements. ODW also investigated the voluntary activities of waterworks engaged in lead

service line replacement, for waterworks known to have some lead services lines, but which were not specifically required to replace service lines under LCR guidelines (that is, for waterworks in Tier/Categories 1A or 1B that had not exceeded the lead action level during first draw tap sampling events). Results from this review are reported in Appendix H.

Finally, ODW conducted a comprehensive review of the most recent lead data reported for Virginia's public waterworks. The particular focus of this review was to ensure that waterworks with recent 90<sup>th</sup> percentile lead test results greater than 15 µg/L for the last sample summary were taking appropriate steps to achieve and sustain compliance with LCR requirements (Appendix I).

## **Outcomes and Conclusions**

### **Child Daycare and Elementary School Sampling Results**

Of the 250 elementary schools and child daycares identified for sampling from the Working Group's priority list, 237 voluntarily participated in the study.

The spatial distribution of participants statewide is shown in Figure 1. Elementary school and child daycare facilities that obtain their water as customers of municipal supplies are shown as dots. Participating elementary schools and child daycares that are identified in SDWIS as NTNC waterworks are shown as crosses.

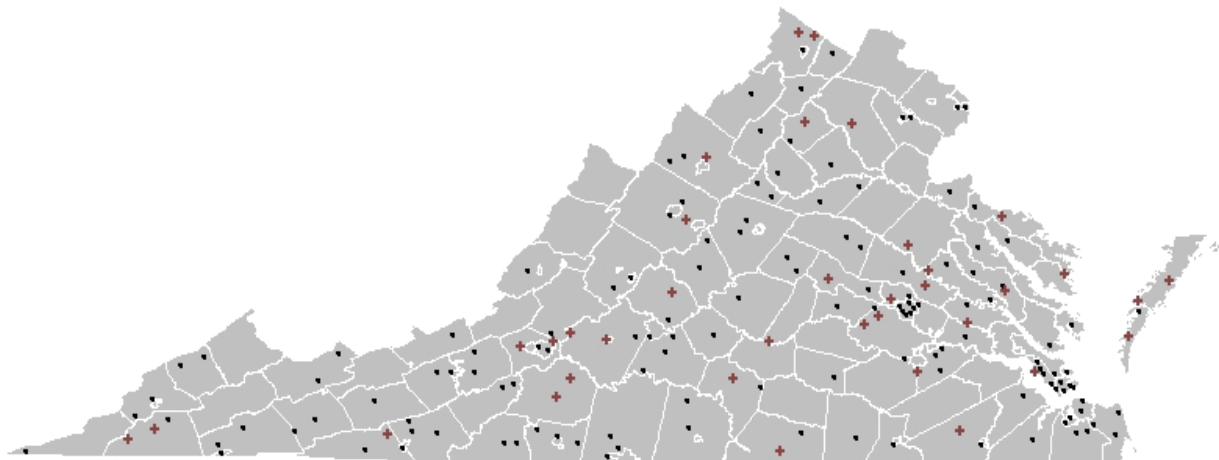


Figure 1.

Some clustering of facilities is indicated in the Richmond and Tidewater regions of the state, corresponding to sites for proposed CLPPP environmental studies. Elementary schools in Northern Virginia are under-represented, because they sampled independently of the VDH Lead Action Plan. Sampling data are tabulated in Appendix D.

### **First Draw and 60-second Flush Sample Results**

The 237 sites produced 174 first draw sample results below the analytical detection level of 2 µg/L. This represents 73% of the sampled sites. Of the 63 samples with detectable lead concentrations, results ranged between 2 and 94 µg/L, with an average concentration of 9.1 µg/L. Only eight sites (representing 3.4 % of the sampled sites) yielded tap samples with lead concentrations greater than 15 µg/L in the first draw. Figure 2 shows the incidence and degree of lead contamination in the first draw samples, with a preponderance of samples showing only trace or undetectable concentrations of lead.

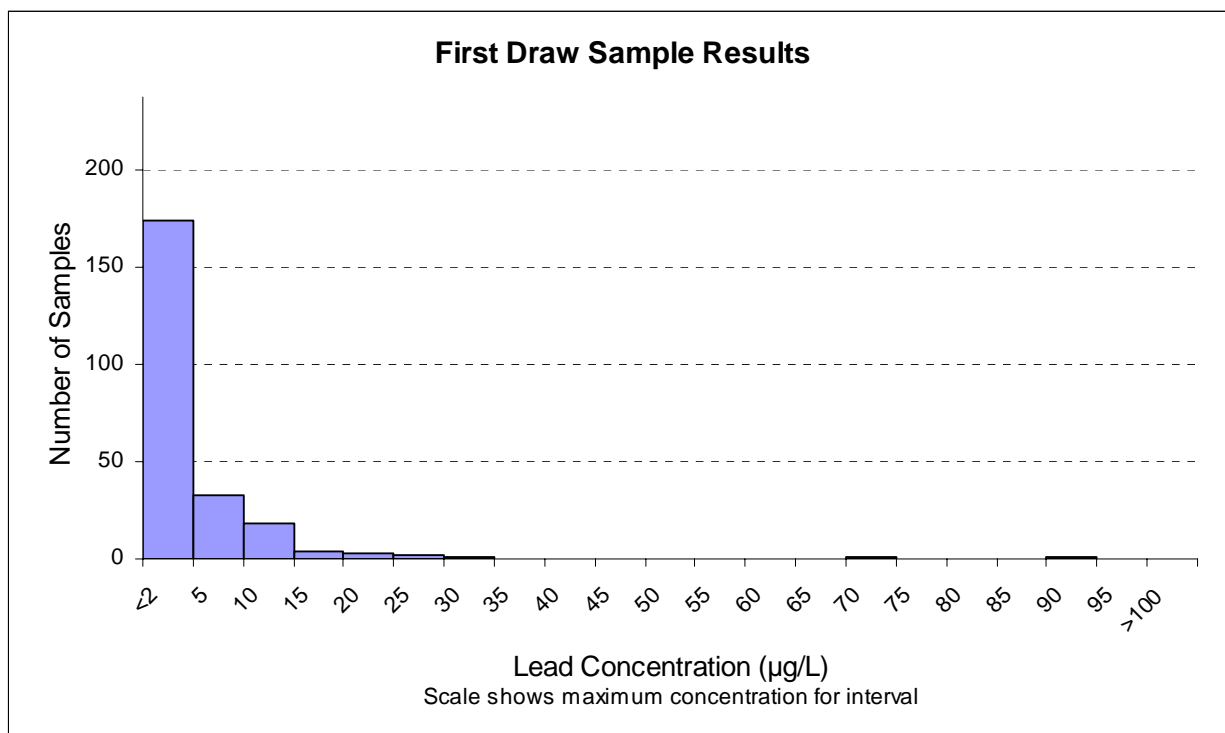


Figure 2

In general, taps that were flushed for 60 seconds showed substantial reduction in lead concentrations, relative to the prior first draw sample (Figure 3). Lead concentrations were below the detection level of 2 µg/L in 216 of the 60-second flush samples (represents 91 % of the sampled sites). Only one tap flushed for 60 seconds continued to exhibit a lead concentration greater than 15 µg/L after flushing (representing 0.4 % of the sampled sites).

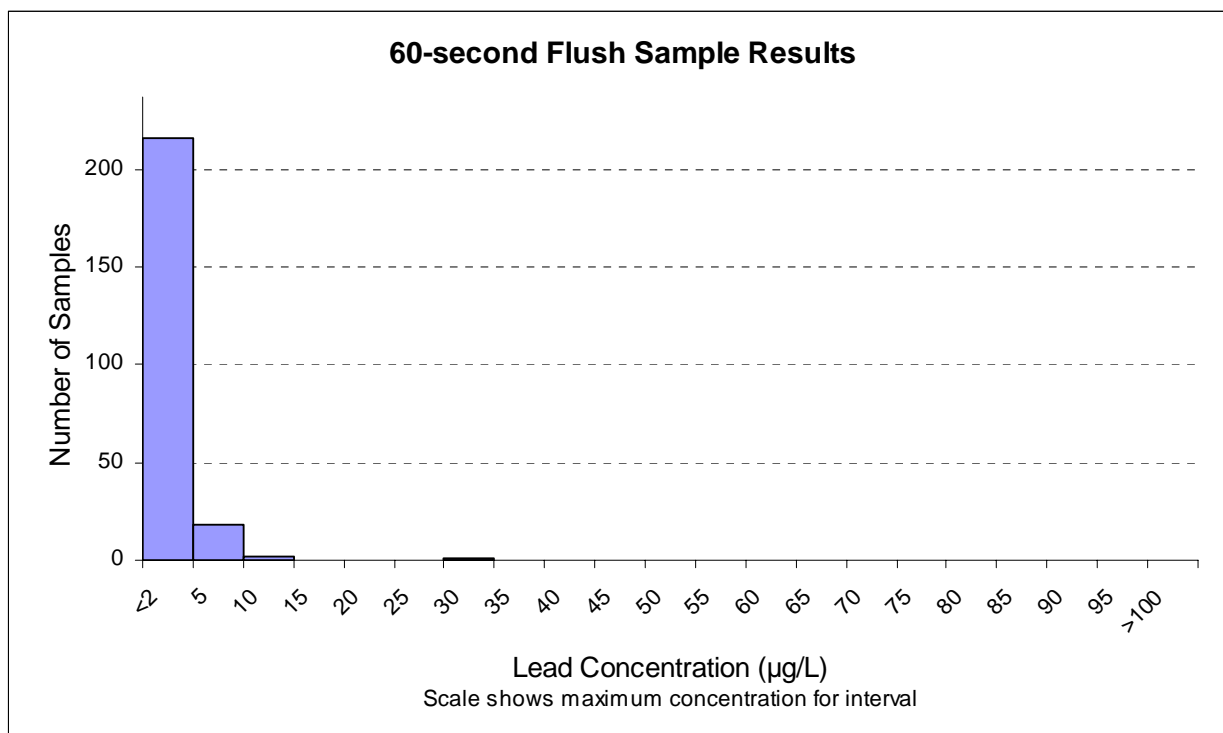


Figure 3

Despite this pronounced trend, several anomalous results were reported. Six taps with undetectable or trace lead concentrations in the first draw sample exhibited a negligible concentration increase in the subsequent 60-second flush sample. At such low concentrations, this minor variability is probably an artifact of laboratory instrument sensitivity. Only one sample site exhibited a marked lead concentration increase in the flushed sample, which is most likely the result of mislabeling the paired first draw and 60-second flush samples.\* If valid, this result may be indicative of lead materials leaching early in the water delivery system (from materials in the well pump, for instance), rather than from materials or fixtures in close proximity to the tap.

Of the taps with first draw lead concentrations greater than 15 µg/L (the lead action level), all but one saw reduction to lead levels below this level after a 60-second flush (Figure 4).

\* The first draw result indicated a lead concentration below the detection level, with the subsequent flushed sample yielding a lead concentration of 10 µg/L. This sample was collected at an elementary school that is an NTNC waterworks.



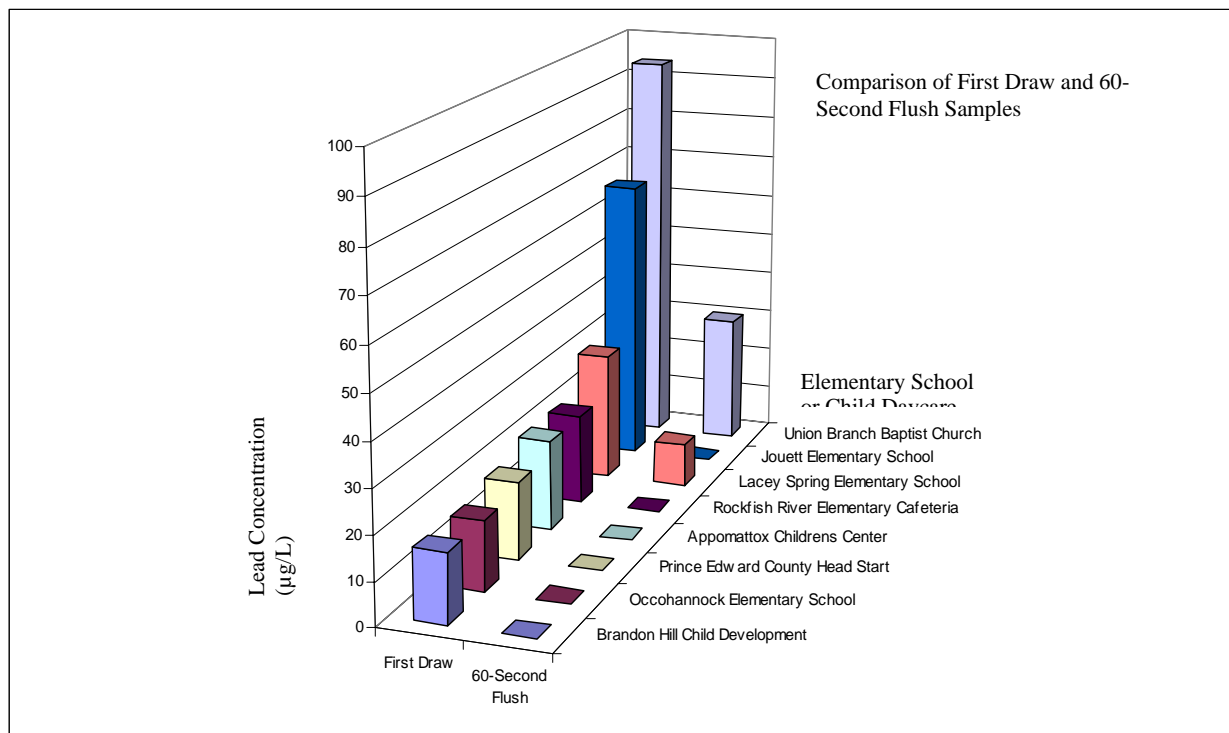


Figure 4.

Taps with first draw concentrations greater than 15 µg/L were revisited for follow-up sampling.; only three remained elevated on the first draw - second sample event. As noted above, one tap at a child day care did not exhibit a reduction of the lead level through flushing to a point below 15 µg/L. A similar outcome was obtained at this site during follow-up testing. This system is a newly regulated system that had not completed its initial testing. This elevation would have been discovered through routine testing, but it was discovered earlier through the sampling program reported here. This facility was visited by ODW field staff for additional investigations, and a letter with detailed recommendations has been sent to the facility (Appendix J).

## **Distribution of Educational Materials to Child Daycare Facilities and Elementary Schools**

The cover letters and Fact Sheets that were distributed to elementary schools and child daycares generated little response or inquiry to ODW offices. This is somewhat surprising given that the information was provided to approximately 12,000 entities. This may be explained by the following:

- The information was not new to many of the facilities; a similar distribution was made in 1991.
- Facilities do not believe they have a problem with lead in drinking water.
- The Fact Sheet provided sufficient information.
- Additional information was obtained at the ODW website, for which a link was provided in the Fact Sheet. For the month of June 2004, the lead in drinking water webpage was the most popular page on the ODW website, with 168 visits and an average viewing time of 2 minutes and 42 seconds.

## **Discussion of Lead Service Lines and Follow-up**

Based on an approved materials survey previously completed for each waterworks, Tier/Category designations are made for each public waterworks before tap sampling commences. Nine public waterworks in Virginia were assigned to Tier/Categories 1A and 1B, indicating the presence of lead service lines. For these waterworks, ODW field office staff contacted the waterworks to determine what has been done, if anything, to replace or otherwise address lead service lines in their respective distribution systems. These waterworks tend to be larger towns or cities with older infrastructure. None of these waterworks are required to perform mandatory lead service line replacement under LCR guidelines. However, in the majority of cases the waterworks are voluntarily taking action to remove lead service lines by implementing an ongoing line replacement program when work is done on the customer's portion of the service line. This information is presented in tabular format in Appendix H.

## **Discussion of 90<sup>th</sup> Percentile Exceedences**

A review of the information provided by ODW field offices showed that 41 waterworks reported 90th percentile results exceeding the lead action level during the latest compliance sample cycle. Of the 41 waterworks, 13 were classified as residential, 12 as schools, and the rest as churches, commercial/industrial, and government/institutional. The status of each waterworks was reviewed to determine the corrective actions that were being taken to address the high results. In the majority of cases the waterworks was complying with the requirements by taking the following actions:

- Distributing public education materials.
- Collecting additional samples.
- Conducting a corrosion control study and recommending a treatment method.
- Installing appropriate corrosion control treatment and resampling.

There were some minor incidents where waterworks were behind schedule in completing the required actions.

## **Conclusion**

Although the special sampling program provided only a snap-shot of the occurrence of lead in drinking water at a single point in time, and at only one fixture in each facility, it still indicated that, in general, lead levels are quite low for the sample pool. Of the sampling pool, 73% of the first draw sample results were below the detection limits. Only 3.3 % of sites sampled showed a first draw result greater than the action level. If the results of the special sampling program are extrapolated to represent the whole state, the data indicate that there is not a widespread problem with lead in drinking water in Virginia's elementary schools and child daycares. In the rare, isolated cases where elevated lead concentrations exist, facilities have been advised that they can reduce the exposure to lead in drinking water by simply letting fixtures run for 60 seconds after water has remained in the lines for an extended period of time.

However, all facilities should take the simple precautions of running tap water prior to consumption and periodically test tap water for the presence of lead.

A review of activities required by the LCR revealed that the waterworks and ODW staff have properly implemented the rule. Notification procedures have been modified to require waterworks to inform customers of elevated lead results in a timely fashion. In addition, on-going programs undertaken voluntarily by many waterworks continue to reduce the public's exposure to lead in drinking water through lead service line replacement.

The existing protocols and procedures for public water supplies seem to be adequate to provide representative monitoring of the presence of lead, trigger appropriate corrective actions in a timely fashion, and provide for adequate public education on precautions that can be taken to reduce potential lead exposure. This results in a program that effectively protects the children (the most sensitive subgroup) and the residents of the state from the hazards of exposure to elevated levels of lead in drinking water.

## **Acknowledgements**

It is important to recognize the extraordinary efforts made by the staff of local health departments, the ODW central office and field offices, and DCLS in implementing the action plan. This effort was undertaken in addition to their normal work duties, and often required tasks to be completed outside of normal work hours and within a very short time period. The successful execution of this plan was due to their cooperation and hard work. Likewise, the elementary school and child daycare sampling program could not have taken place without the generous participation of the facilities that agreed to voluntarily submit to sampling. The Working Group hopes that the information provided here will help planners assess the risks of lead in drinking water and gauge the responses required for effective solutions.